IMPROVING CONFIDENCE IN LONG-TERM DOSE ASSESSMENTS FOR U-238 SERIES RADIONUCLIDES

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Many organisations have an interest in the long-term radiological impacts of environmental releases of U-238 series radionuclides. Particular interest arises because of the very long half-lives and radiation doses contribution of some of the radionuclides involved. These are much longer than the stability of near-surface environments and the likely period of effectiveness of engineered barriers in shallow disposal concepts. The half lives are also significant in relation to the containment that can be provided by deep geological disposal concepts. The issues associated with modelling the behaviour of U-238 and its progeny in the near-surface geosphere and biosphere are therefore of interest in relation to conventional radioactive waste disposal, are also of interest to uranium mining and milling legacies and the waste management situations from NORM industries. There is commonly a need to consider the full U238 decay chain, or at least several members of it, in order to fully address disequilibrium and migration issues, including radon emanation in different environmental situations. In 2010, the international BIOPROTA forum (www.bioprota.com) established a working group to investigate the assessment of U-238 series radionuclides in a terrestrial ecosystem. Participants include: Andra, CIEMAT-ENRESA, the UK Food Standards Agency (FSA), NDA RWMD, NUMO, NWMO and SKB. The current phase of work is focussed on the U-238, U-234, Th-230 and Ra-226 chain members. Building upon work carried out by the International Union of Radioecology, interaction matrices of the system features, events and processes (FEPs) have been developed for each of these radionuclides. Seven models have been identified for auditing against the FEP interaction matrices as part of an initial qualitative model inter-comparison, these models are: (i) the soil redox model used by CIEMAT, (ii) Andra's multi-layer near surface transfer (SAMM) model, (iii) NDA RWMD's current Biosphere Assessment Tool, (iv) RESRAD-OFFSITE, (v) the model used in remediation projects by Wismut GmbH, (vi) NWMO's SYVAC3-CC4 model and (vii) the FSA's PRISM model. As part of a subsequent quantitative model inter-comparison, these models were applied to calculate the concentrations of U-238, U-234, Th-230 and Ra-226 at the soil surface and in the edible parts of the harvested crops, with both exposure routes contributing to exposure of representative persons (the former via direct exposure, and the latter via ingestion). In this assessment scenario, it was assumed that contaminated water is abstracted from a well and used for irrigation. In addition to this main scenario, where all four radionuclides are considered, variant scenarios where either U-238 or Th-230 is the only radionuclide in the irrigation water were also considered. In these variant scenarios, the progeny that grow in exhibit behaviour that is

strongly different from their parents, both in regard to physical transport as well as root uptake. In addition to these scenarios, an upward flux scenario from a hypothetical U-bearing source is evaluated and compared with data from the Los Ratones uranium mine site, south west Spain. Results from these analyses are presented, together with a discussion of implications for improving confidence in long-term dose assessments for U-238 series radionuclides.